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CBO

STUDY

The Army's Future Combat Systems Program and Alternatives

August 2006

The Congress of the United States ■ Congressional Budget Office

Notes

Unless otherwise indicated, all years referred to in the study are federal fiscal years (which run from October 1 to September 30), and all costs are expressed in 2006 dollars.

Numbers in the text and tables may not add up to totals because of rounding.

Cover art from the Department of the Army.

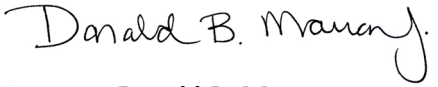
Preface

The Army is attempting to transform itself from a force designed primarily to fight large and protracted wars in a limited number of locations to one capable of reacting rapidly to crises anywhere in the world. In its endeavor to make its combat units more versatile and agile, the Army is planning to replace its heavy, aging armored combat vehicles with newer, lighter systems that it expects will be as lethal and survivable as the vehicles they are replacing. Several types of manned vehicles as well as unmanned aerial and ground vehicles, missile launchers, and communications links would be developed and procured within a single program known as the Future Combat Systems (FCS) program.

This study by the Congressional Budget Office (CBO), which was prepared at the request of the Ranking Member of the Tactical Air and Land Forces Subcommittee of the House Committee on Armed Services, considers the near- and long-term implications of the FCS program. It also examines several alternatives for modernizing the Army's armored forces and estimates the costs and savings associated with those options as well as their effects on the Army's fleet of armored vehicles and the ability of its armored units to deploy overseas. In keeping with CBO's mandate to provide objective, impartial analysis, the report makes no recommendations.

Frances M. Lussier of CBO's National Security Division prepared the study under the general supervision of J. Michael Gilmore. The author would like to thank Michael J. Bennett of CBO for his assistance in fact-checking the document as well as former Department of Defense official Thomas P. Christie for his comments and Army personnel for their help. (The assistance of external participants implies no responsibility for the final product, which rests solely with the author and CBO.) Victoria Liu, also of CBO, reviewed the manuscript, and Arlene Holen, Sarah Jennings, Jo Ann Vines, Jason Wheelock, and Christopher Williams provided comments on earlier drafts of the study.

Leah Mazade edited the report, and Christine Bogusz proofread it. Cindy Cleveland produced drafts of the text and tables, and Maureen Costantino designed the cover and prepared the study for publication. Lenny Skutnik produced the initial printed copies. This publication and others may be found at www.cbo.gov.



Donald B. Marron
Acting Director

August 2006

Summary

Roughly half of the Army's combat forces at the end of 2005 were so-called heavy units—forces that are equipped with armored vehicles and that provide significant firepower. To support those units, the Army maintains a fleet of approximately 28,000 armored vehicles. Now that the Cold War is over, some defense experts have questioned the relevance of such vehicles to the current national security strategy and their continued usefulness (notwithstanding their contributions to recent operations, such as Desert Storm and Iraqi Freedom). The average age of the armored combat vehicle fleet at the end of 2005 was relatively high, and the fleet comprises vehicles designed several decades ago. Moreover, units equipped with the vehicles in the current fleet are too large and too heavy to be moved overseas easily and quickly by the Air Force's C-17s, the most numerous of its long-range transport planes. For all practical purposes, heavy units must be transported overseas by ship—a process that takes weeks.

In today's environment of rapidly evolving conflicts, the Army's goal is to have units that have the combat power of heavy units but that can be transported anywhere in the world in a matter of days. To address concerns about the armored vehicle fleet's aging and the difficulties involved in transporting it—as well as to equip the Army more suitably to conduct operations overseas on short notice using forces based in the United States—the service created the Future Combat Systems (FCS) program in 2000. A major modernization effort, the program is designed in part to develop and purchase vehicles to replace those now in the heavy forces; the new vehicles would be much lighter, thereby easing the deployment of units equipped with them. But the FCS program, poised to develop a total of 18 new systems (including eight manned vehicles to replace those in the Army's current armored fleet) and a network to connect them all will not field any new vehicles until December 2014 at the earliest. Furthermore, because those new vehicles will be expensive, the Army plans to buy relatively small quantities of them each year. As a result, the armored vehicles now in the Army's combat units will not all be replaced by FCS components until after 2035, a prospect that has evoked concerns about the costs of maintaining those older vehicles and upgrading them to prevent their becoming obsolete.

In addition, questions have been raised about the FCS program's technical feasibility and affordability. Some experts doubt that the Army can develop and test the necessary technologies in time to start producing lightweight manned vehicles by 2012—a requisite for meeting the deadline to field them according to the Army's current schedule. Another concern is funding for the quantities of FCS equipment that the Army is now planning to buy. Any reduction in the FCS procurement rate would force the Army to retain its already aging armored vehicles even longer and to invest more funds in their maintenance.

In the analysis presented in this report, the Congressional Budget Office (CBO) examined the current status of the Army's fleet of armored vehicles and assessed the speed of deployment of the service's heavy forces. It also evaluated the FCS program, considering the program's costs as well as its advantages and disadvantages and comparing it with several alternative plans for modernizing the Army's heavy forces.[1] CBO's analysis supports the following observations:

- The FCS program must surmount substantial technical and funding challenges if it is to develop and initially field all of the individual FCS components as currently scheduled—that is, by December 2014.

1. A fuller discussion of the four alternatives that CBO evaluated, each of which emphasized different aspects of the FCS program—information collection and sharing (Alternative 1); long-range strike missions (Alternative 2); new vehicular technology (Alternative 3); and integrating the FCS network into existing systems (Alternative 4)—can be found later in this summary.

- According to the Army's estimates, total annual costs to purchase the various FCS components could approach $10 billion. However, if such costs grew as those of similar programs have in the past, annual costs could reach $16 billion.

- Moreover, if the Army fielded FCS vehicles according to its current schedule, $1 billion or more of additional funding might be needed annually from 2010 through 2016—and smaller amounts thereafter—to maintain and upgrade the Army's inventory of aging ground combat vehicles.

- Although one of the main purposes of the FCS program is to speed the movement of Army combat units overseas, replacing the current fleet of armored vehicles with FCS components will not significantly reduce deployment times.

- Alternatives to the currently planned FCS program that would eliminate all or part of the program's ground vehicles while retaining its communications equipment and, in some cases, its sensors would reduce the program's average annual costs to about $5 billion to $7 billion. Under such alternatives, the Army would incorporate some FCS technologies into its current fleet of armored combat vehicles and upgrade those vehicles at the same time, thereby increasing their capabilities and extending their useful lives. However, if it did so, the Army would forgo potential benefits of the capabilities it now seeks in the FCS program.

Description of the Army's Future Combat Systems Program

The FCS program was first conceived by then Army Chief of Staff General Eric Shinseki to enable the Army to react to overseas crises more quickly and with overwhelming combat power. The service initiated the program to develop a new generation of combat vehicles that would be as lethal and survivable as the heavy weapons it now fields but that would weigh much less, be more easily transported, and require far less logistical support.

According to the Army, the FCS program would greatly enhance the capabilities and agility of its heavy units by developing new systems to replace most of the combat vehicles that currently equip the service's heavy units and by developing and buying several types of unmanned aerial and ground vehicles to provide remote—and sometimes autonomous—surveillance and protection. Specifically, the Army would develop eight new types of armored vehicles, four classes of unmanned aerial vehicles (UAVs), three types of unmanned ground vehicles, unattended ground sensors, a missile launcher, and intelligent munitions, all of which would be linked by an advanced communications network into an integrated combat system.

Manned FCS Vehicles

The eight new manned vehicles that would be developed through the FCS program are intended to replace the armored vehicles currently assigned to the Army's heavy combat units (see Summary Table 1). The eight variants would share a common chassis and engine as well as other components, which would reduce the logistics burden associated with maintaining them. The vehicles would have new weapons, sensors, and types of protection, making them, according to the Army, more capable than current systems. The FCS vehicles are also being developed to be more fuel efficient; some armored vehicles in the Army's current fleet—notably the Abrams tanks and Bradley fighting vehicles—go less than two miles on a gallon of fuel.

Initially, the Army aimed to develop FCS vehicles that weighed less than 20 tons and that could be transported by the Air Force's C-130 aircraft. However, the weight limit for the initial design of the manned FCS ground vehicles has been relaxed and is now set at 24 tons—which would nevertheless be about one-third of the weight of the latest model of the Abrams tank and roughly three-quarters that of the Bradley fighting vehicle.

Unmanned Aerial and Ground Vehicles

Four classes of unmanned aerial vehicles and three types of unmanned ground vehicles would be developed under the FCS program to provide, along with the manned systems, surveillance, protection, and cargo-carrying capacity. The aerial vehicles would have varying capabilities: for example, the smallest, Class I, UAV would weigh less than 15 pounds, have a range of eight kilometers (km), and be able to stay aloft for about one hour, whereas the largest, Class IV, UAV could weigh more than 3,000 pounds, have a range of 75 km, and be able to stay aloft for up to 24 hours. The three types of unmanned FCS ground vehicles, or robots, are intended in general to lighten the load of individual soldiers by providing continuous surveillance, carrying supplies, or investigating

Summary Table 1.

FCS Components and Current Counterparts in Combat Brigades

Component	Mission	Existing System Being Replaced
	Manned Vehicles	
Mounted Combat	Destroy the enemy	Abrams tank
Infantry Carrier	Transport and protect soldiers	Bradley infantry fighting vehicle and M113 armored personnel carrier
Reconnaissance and Surveillance	Scout	Bradley cavalry fighting vehicle
Non-Line-of-Sight Cannon	Provide fire support	M109 howitzer
Recovery and Maintenance	Recover stranded vehicles	M88 recovery vehicle
Command and Control	Transport and protect commanders	M113-based vehicle
Non-Line-of-Sight Mortar	Provide fire support	M113-based vehicle
Medical	Treat and evacuate the wounded	None
	Unmanned Ground Vehicles	
Armed Robotic	Perform sentry duty; provide cover	None
Multifunction Utility, Logistics, and Equipment	Carry cargo; detect and counter mines	None
Small Unmanned Ground	Investigate small, confined spaces	None
	Unmanned Aerial Vehicles	
Class I	Provide surveillance up to a distance of 8 km	Raven
Class II	Provide surveillance up to a distance of 16 km	None
Class III	Provide surveillance and communications relay up to a distance of 40 km	Shadow
Class IV	Provide surveillance and communications relay up to a distance of 75 km	None
	Other	
Non-Line-of-Sight Launch System	Carry out precision attacks up to a distance of 70 km	None
Unattended Ground Sensors	Detect and identify intruders	REMBASS
Intelligent Munitions System	Channel enemy movement	"Smart" land mines

Source: Congressional Budget Office based on data from the Department of the Army; Army Project Manager, Unit of Action, "Future Combat Systems (FCS); 18+1+1 Systems Overview" (September 2005); and Army Training and Doctrine Command (Tradoc), Unit of Action Maneuver Battle Lab and Tradoc System Manager FCS, "Family of Systems Battle Book" (January 31, 2005).

Note: FCS = Future Combat Systems; UAV = unmanned aerial vehicle; km = kilometer; REMBASS = remotely monitored battlefield sensor system.

high-risk areas or locations (for example, tunnels or caves).

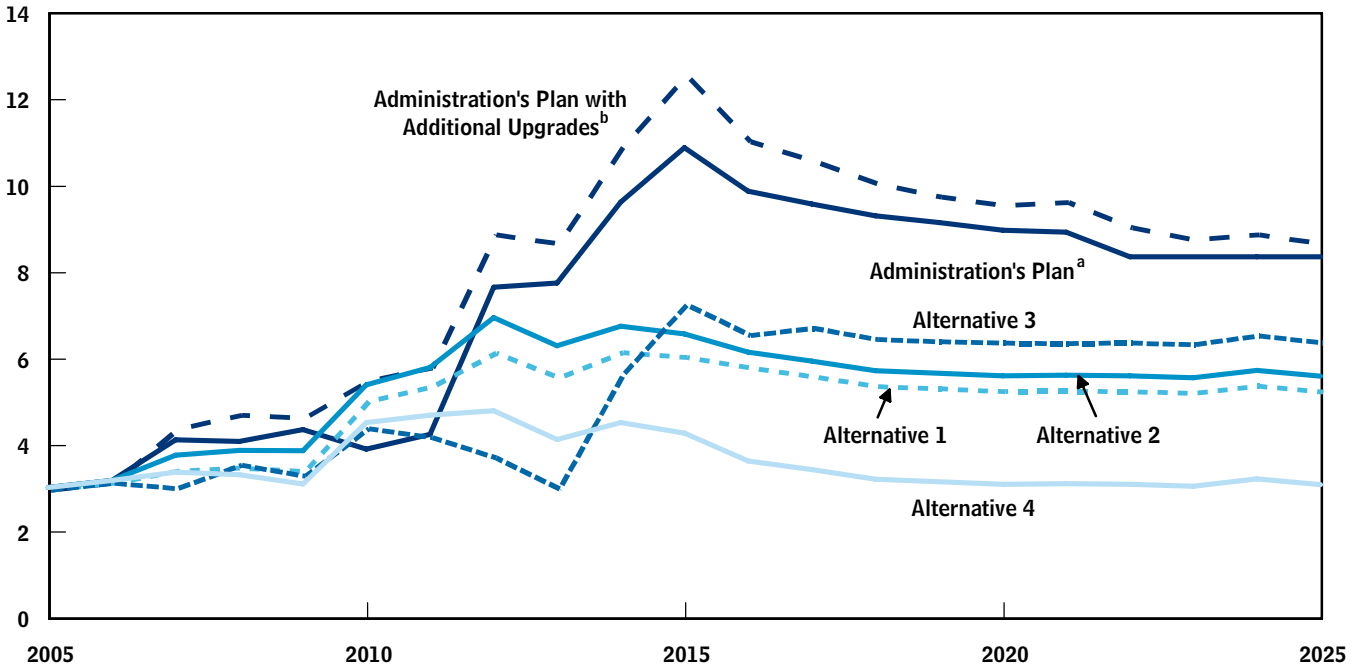
Unattended Sensors, Intelligent Munitions, Launchers, and the Network

The remaining hardware systems to be developed under the FCS program include ground sensors, a missile launcher, an intelligent munitions system, and equipment associated with the communications and data-sharing network. The unattended ground sensors are small modules equipped with several different types of sensors that are intended to act as remote sentries and provide early warning of an attack. The intelligent munitions system is based on sophisticated land mines that can self-destruct on command or at a specific time. The ground sensors and the munitions system are designed to be relatively inexpensive and to detect and destroy intruders over a wide area. The non-line-of-sight launch system—a box-shaped launcher equipped with 15 advanced missiles—may be operated remotely or set to operate autonomously; it is intended to carry out rapid-fire attacks on targets at a distance of as much as 70 km.

Summary Figure 1.

Annual Costs of the Administration's Plan for the Future Combat Systems Program and Alternatives

(Billions of 2006 dollars)



Source: Congressional Budget Office.

Note: See Summary Table 4 for details of the alternatives.

a. Based on documents submitted with the President's 2007 budget, which includes $6 billion for upgrades to existing systems.

b. Includes upgrades to Abrams tanks, Bradley fighting vehicles, M113-based vehicles, and M109 howitzers to maintain a relatively constant average age for each fleet of vehicles after 2011.

The final component of the FCS program is the network, which comprises the common operating software that would allow all of the FCS elements to communicate with one another and with other Army systems and to share data. The network also includes the communications and computer systems that are planned to provide secure, reliable access to information collected by the many surveillance sensors in the future FCS-equipped brigade.

Schedule for Fielding FCS Components

Despite the complexity and diversity that the 18 individual FCS components represent, the Army plans to field them all on a very tight schedule. Components would be introduced in stages (which the Army refers to as spin-outs, or spirals); fielding would begin in 2010 with the unattended ground sensors, the non-line-of-sight launch system, and the intelligent munitions system. However, the Army does not expect to field the first combat brigade to be equipped with all 18 systems until December 2014. After that, the service plans to equip its combat brigades with FCS components at a maximum rate of 1.5 brigades per year, purchasing 15 brigades' worth of equipment as part of the first installment—or "increment"—of procurement for the program.[2] Under the current schedule, equipment for the 15th brigade would be purchased in 2023, allowing fielding of those systems in 2026.

2. Procurement of FCS components is often discussed in terms of a brigade's worth of equipment, which includes more than 300 manned vehicles, approximately 230 unmanned ground vehicles, more than 200 UAVs, and numerous additional unattended ground sensors, launch systems, and associated munitions.

Costs of the Army's FCS Program

The FCS program represents by far the biggest single investment that the Army is planning to make during the next 20 years. The research and development (R&D) portion of the program is scheduled to extend through 2016 and cost a total of $21 billion from 2007 to 2016. The Army estimates that total procurement costs for the first 15 brigades' worth of systems will be about $100 billion, or an average unit procurement cost per brigade of $6.7 billion.[3] The Army plans to start its annual purchases of 1.5 brigades' worth of equipment in 2015; as long as the program continues purchases at that rate, from that year on it will require annual funding of $8 billion to $10 billion (see Summary Figure 1).

Concerns About the FCS Program

The Government Accountability Office (GAO) and other defense experts have expressed a number of reservations about the Army's ability to implement the FCS program in its current form. Among their concerns are the technological challenges facing developers of the various systems; the costs of the program, in light of the Army's other funding needs; the condition of the service's current fleet of armored vehicles, which will be retained for several decades until they can be replaced by FCS vehicles; the limited improvement in the speed of Army units' deployment that the fielding of FCS components is likely to bring; and the survivability of FCS vehicles in hostile environments.

Technological Readiness of FCS Components

Defense analysts have questioned whether the planned FCS components will be ready to go into production in 2012. GAO, for example, has criticized the Army's proposed schedule for developing and fielding the 18 systems, given that, according to GAO, it would require developing multiple systems and a network in the same amount of time that the Department of Defense (DoD) typically takes to develop a single advanced system.[4] Also according to GAO, none of the numerous technologies that are critical to developing the various FCS components—technologies that should have been "mature" before the program entered the system development and demonstration (SDD) phase in 2003—were judged to be so in an independent assessment dated April 2005.[5] Using GAO's criteria, those technologies may not be mature until 2012, when the first FCS component is slated to go into production.

Another technological hurdle is development of the software that will allow all of the new systems to communicate and share data with one another and with the Army's existing systems. At least 34 million lines of software code must be generated—about twice the amount needed for the Joint Strike Fighter, DoD's largest software development effort to date.

The severity of the technological challenges associated with developing all 18 FCS components and the network to link them has already led to increases in the time and funds allotted to FCS development. As the program was first described by General Shinseki in October 1999 and as the schedule stood in November 2002, FCS development would have included a relatively short (three-year) SDD phase starting in the spring of 2003, with all 18 systems slated to enter production by 2006 and to start initial fielding in 2008. Since then, the schedule has been extended by more than six years, and the first unit to be equipped with all 18 systems will not be fielded until December 2014 (fiscal year 2015) at the earliest.

Growth of the FCS Program's Costs

As noted earlier, the Army estimates that the FCS program will require $8 billion to $10 billion annually starting in 2015, when it plans to begin buying 1.5 brigades' worth of equipment per year. During the preceding five years, the program will have consumed increasingly larger shares of the Army's procurement budget: if the Army's

3. CBO was unable to develop an independent estimate of the cost of a brigade's worth of equipment because some of the individual FCS components are not yet fully defined.

4. Statement of Paul L. Francis, Director, Acquisition and Sourcing Management, Government Accountability Office, before the Subcommittee on AirLand of the Senate Committee on Armed Services, published as Government Accountability Office, *Defense Acquisitions: Future Combat Systems—Challenges and Prospects for Success*, GAO-05-442T (March 16, 2005).

5. A fully mature technology, according to GAO's definition, is one that has been demonstrated in a prototype in an operational environment. In contrast, the Army considers a system that has been demonstrated in a prototype in a relevant environment to be sufficiently mature to be used in the SDD phase. The April 2005 independent assessment (Office of the Deputy Assistant Secretary of the Army for Research and Technology, *Technology Readiness Assessment Update*) was cited in Government Accountability Office, *Defense Acquisitions: Improved Business Case Is Needed for Future Combat System's Successful Outcome,* GAO-06-367 (March 2006).

procurement funding grew after 2011 at a rate equal to inflation—that is, if it remained at the same level in 2006 dollars—the FCS program's share of the service's planned $21 billion procurement budget would rise from almost 6 percent in 2011 to roughly 50 percent in 2015 and remain at or above 40 percent through 2025. (For comparison, the Army's purchase of ground combat vehicles during the 1980s peaked at 20 percent of the Army's total procurement budget.) Dedicating such a large proportion of the service's procurement funding to the FCS program would leave little money for purchasing other weapon systems (such as helicopters) or needed support equipment (such as generators and ammunition).

Also giving rise to experts' concerns is the fact that the FCS program has already experienced significant cost growth since it entered the SDD phase in spring 2003. At that time, the program's total acquisition cost for 15 brigades' worth of equipment—that is, including research, development, testing, evaluation, and procurement—was projected to be about $80 billion. The Army's latest estimate of that cost has increased to almost $130 billion, or roughly 60 percent more than its original estimate.[6] And if the history of the Army's major weapons programs is any indication, the costs of the FCS program may continue to rise. Historical trends suggest that DoD's major programs experience growth in R&D costs ranging from 16 percent to slightly more than 70 percent and growth in procurement costs ranging from 11 percent to roughly 70 percent—as measured from estimates prepared when the programs entered the SDD phase. (The higher end of the range reflects historical cost growth for ground vehicles.)

Overall, the different types of equipment that the FCS program plans to develop lead CBO to estimate that the Army's acquisition costs may grow by about 60 percent. Given some defense experts' view that the program's entry into the SDD phase was premature, the FCS program may continue to experience cost growth at historical rates. If it does, the average annual funding needed for the program, CBO estimates, may climb from the $8 billion to $10 billion projected most recently by the Army to between $13 billion and $16 billion.

Age of the Army's Armored Combat Vehicle Fleet

The total size of the FCS program—in terms of number of brigades' worth of equipment purchased—and the rate at which the program is executed will determine how many of the armored vehicles in the Army's current inventory must be retained and for how long. At the end of 2005, the Army had an armored combat vehicle fleet of almost 28,000 vehicles, including 5,850 Abrams tanks, 6,650 Bradley fighting vehicles, 13,700 vehicles based on the M113 personnel carrier, and 1,500 M109 self-propelled howitzers. Those vehicles, and the armored combat fleet as a whole, are aging. M113-based vehicles, which constitute almost half of the fleet, were first introduced into Army units in the 1960s. Most of the rest of the service's armored vehicles—namely, the Abrams tanks and Bradley fighting vehicles—are based on technology that is roughly 20 years newer. But at the end of 2005, even those vehicles, which have undergone several upgrades since they were first produced, had average ages of 15 and 11 years, respectively. Many of the vehicles that provide much of the Army's current combat power could thus reach the end of their useful service (based on a useful service life of 20 to 30 years) in the next decade—unless DoD invests significant sums in upgrading or modifying them.

The Army is currently reorganizing its fighting forces under what is known as its modularity initiative. That reorganization will reduce both the size of armored units and their total number; consequently, the service will need fewer armored vehicles and could retire more than 13,000 of its oldest by 2011. Those retirements would yield an armored vehicle fleet with a lower average age in that year than would have been possible without the extensive retirements. Nevertheless, the resultant fleet, with an average age of 13 years, would still be relatively old.

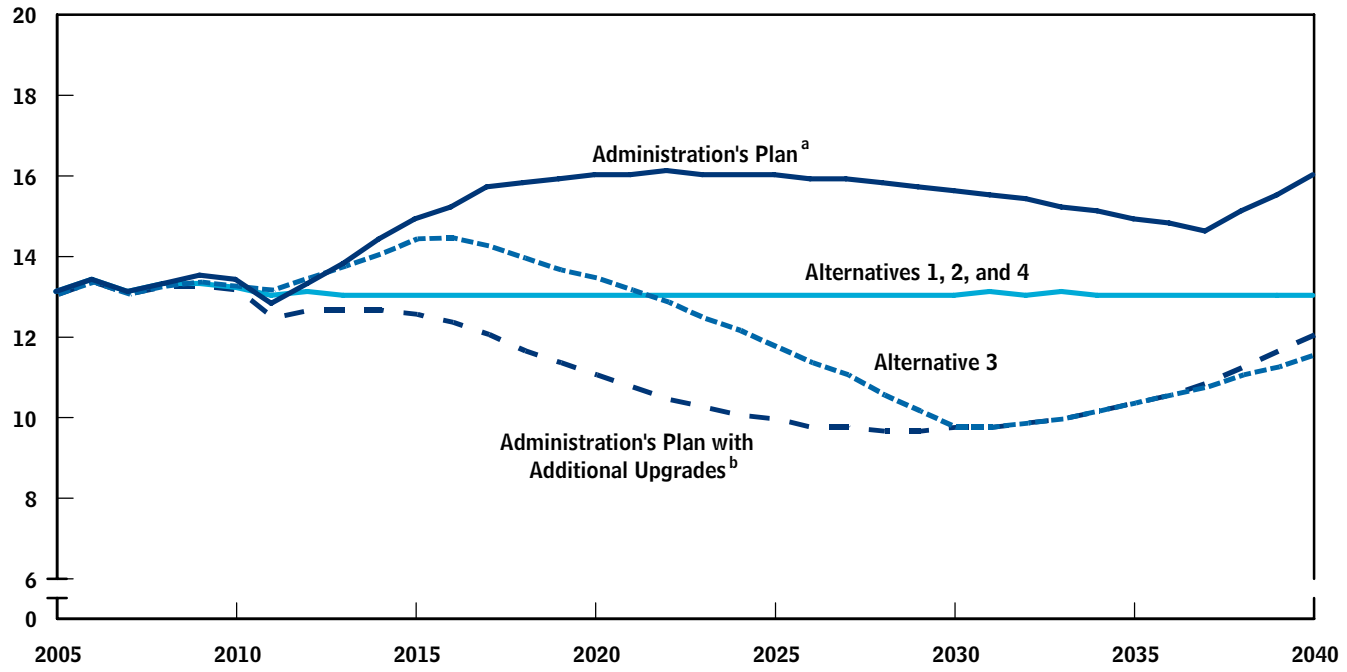
Although the FCS program could ultimately replace most of the armored vehicles that currently equip the Army's combat brigades, the average age of those vehicles before they were retired would significantly exceed the Army's guidelines. Manned FCS vehicles would not begin to be introduced into units until December 2014 at the earliest. By the time the Army began to field significant numbers of them—roughly 500 per year starting in 2018—the average age of the armored combat vehicle fleet would

6. An independent estimate of the cost of the FCS program by the Cost Analysis Improvement Group (CAIG) in the Office of the Secretary of Defense was submitted to the Congress in June 2006 and suggests that the FCS program's costs may be higher than the Army's latest projections indicate. According to the CAIG, total acquisition costs for the FCS program, including costs for R&D and procurement, could range from $160 billion to $173 billion (in 2006 dollars).

Summary Figure 2.

Effect of the Administration's Plan for the FCS Program and Alternatives on the Average Age of the Army's Active Armored Combat Vehicle Fleet

(Average age in years)



Source: Congressional Budget Office.

Notes: See Summary Table 4 for details of the alternatives.

The "active fleet" comprises all models of the vehicles that CBO estimates will be needed to equip and support modular units in both the Army's active component and the Army National Guard. (Modular units are those resulting from the Army's ongoing modularity initiative, which seeks to make the service more flexible by changing its structure from one based on 18 divisions, several of unique design, to one based on 70 combat brigades, each one of only three designs.)

FCS = Future Combat Systems.

a. Based on documents submitted with the President's 2007 budget, which includes $6 billion for upgrades to existing systems.

b. Includes upgrades to Abrams tanks, Bradley fighting vehicles, M113-based vehicles, and M109 howitzers to maintain a relatively constant average age for each fleet of vehicles after 2011.

be 16 years (see Summary Figure 2). Because the proposed annual purchases of armored vehicles under the FCS program represent only 3 percent of the total fleet, they will not begin to lower the fleet's average age until 2024—and even then, the average age could exceed 15 years (the high end of what the Army considers the desirable range) for the foreseeable future. If the Army continued to purchase manned FCS vehicles after the first 15 brigades' worth had been bought, armored vehicles in the combat brigades and prepositioned sets (brigade-sized sets of equipment that DoD has positioned and maintains in several locations around the world) would have been totally replaced by FCS vehicles by 2037.[7] Until then, however, the Army's current fleet of armored vehicles would need to be maintained in fighting condition.

The Army aims to keep the average age of its armored vehicles at or below half of their useful life by, first, continually upgrading them to reflect the capabilities of the latest models and, second, incorporating FCS technologies into them as the new systems become available. To that end, documents submitted with the President's 2007

7. Some M113-based vehicles and self-propelled howitzers that equip units other than combat brigades could be retained indefinitely.

Summary Table 2.

Comparing the Army's Modular Heavy Combat Brigades and Brigades Equipped with Future Combat Systems

	Modular Heavy Combat Brigade[a]	FCS-Equipped Brigade
Personnel (Number)	3,800	3,300
Vehicles (Number)[b]		
Tracked[c]	370	320
Trucks, trailers, and other[d]	1,310	910
Total vehicles	**1,680**	**1,230**
Weight, All Equipment (Tons)	25,000	18,700
Coverage, All Equipment (Thousands of square feet)	320	260 to 290
Deployment of Equipment		
By air (Number of C-17 sorties)[e]	420	340 to 370
By sea (Number of ships)[f]		
Fast sealift	3	2
Large medium-speed roll-on/roll-off	2	1

Source: Congressional Budget Office based on data from the Department of the Army; Military Traffic Management Command Transportation Engineering Agency, *Deployment Planning Guide: Transportation Assets Required for Deployment*, MTMCTEA Pamphlet 700-5 (May 2001); and Department of the Air Force, *Air Mobility Planning Factors*, Pamphlet 10-1403 (December 18, 2003).

a. "Modular" refers to the Army's ongoing modularity initiative, which seeks to make the service more flexible by changing its structure from one based on 18 divisions, several of unique design, to one based on 70 combat brigades, each one of only three designs. "Heavy" units are those equipped with tracked armored vehicles.

b. Numbers are rounded to the nearest 10 vehicles.

c. Includes all tracked armored vehicles.

d. "Other vehicles" include wheeled vehicles that cannot drive for long distances on roads and the 20 helicopters and 150 unmanned ground vehicles in the FCS-equipped brigade.

e. Based on an average load of 60 tons for modular heavy brigades and 50 tons to 55 tons for FCS-equipped brigades and rounded to the nearest 10 sorties.

f. Either fast sealift ships or large medium-speed roll-on/roll-off ships will be needed but not both. Numbers of ships are rounded up to the nearest whole ship.

budget included roughly $6 billion from 2007 through 2016 for upgrades to Abrams tanks, Bradley fighting vehicles, and M113-based vehicles. To continue those upgrades, pay for modernization of the Army's M109 howitzers, and keep the average age of the vehicles required to equip its heavy units relatively constant after 2011, the Army must invest an additional $17 billion by 2025, in CBO's estimation.[8] That investment could bring the average age of the Army's fleet of combat vehicles down from one that without upgrades would exceed 16 years in 2020 to one that would remain consistently below 13 years (see Summary Figure 2).

Deployment of Army Units

Although a major goal of the FCS program is to make units equipped with armored vehicles easier to deploy overseas, replacing the Army's existing armored vehicles with FCS components will not significantly reduce deployment time. An FCS-equipped force would yield at most a 19 percent reduction in the time needed to deploy

8. In developing that estimate, CBO assumed that in addition to incorporating systems that provided new capabilities, including some of those associated with the FCS network, an upgrade to an existing vehicle would also replace all components (such as engines and transmissions) needed to reset the vehicle's effective age to zero.

Summary Table 3.

Time Needed to Deploy Equipment of Combat Units to East Africa

(Days)

	Airlift[a]	Sealift
Brigade-Sized Units		
Administration's Plan[b]		
Modular heavy brigade with existing armored vehicles[c]	23	25
FCS-equipped brigade	18-20	25
Alternatives		
1. Information collection and sharing	23	25
2. Long-range strikes	24	25
3. New vehicular technology	24	25
4. Existing-system upgrades	23	25
Division-Sized Units[d]		
Administration's Plan[b]		
Four modular heavy brigades with existing armored vehicles[c]	135	27
Four FCS-equipped brigades	115-130	27
Alternatives		
1. Information collection and sharing	140	27
2. Long-range strikes	140	27
3. New vehicular technology	145	27
4. Existing-system upgrades	135	27

Source: Congressional Budget Office based on data from the Department of the Army; Military Traffic Management Command Transportation Engineering Agency, *Deployment Planning Guide: Transportation Assets Required for Deployment*, MTMCTEA Pamphlet 700-5 (May 2001); and Department of the Air Force, *Air Mobility Planning Factors*, Pamphlet 10-1403 (December 18, 2003).

Notes: Units would be moved from the continental United States. The data do not reflect the time needed to move sustaining units or supplies. See the text for more discussion of alternatives.

a. The number of daily sorties constrained by the capacity of the airfield in East Africa, based on average airlift payloads per brigade of 60 tons for modular heavy units and 50 tons to 55 tons for units equipped with Future Combat Systems.

b. Based on documents submitted with the President's 2007 budget.

c. "Modular" refers to the Army's ongoing modularity initiative, which seeks to make the service more flexible by changing its structure from one based on 18 divisions, several of unique design, to one based on 70 combat brigades, each one of only three designs. "Heavy" units are those equipped with tracked armored vehicles.

d. Besides combat brigades, divisions include headquarters and other support units.

heavy brigades by air. Whether equipped with current or FCS components, the Army's heavy units comprise hundreds of tracked (mostly armored) vehicles and hundreds more trucks and trailers that require multiple aircraft sorties to deploy by air (see Summary Table 2). Yet the lack of extensive paved surfaces for receiving and unloading aircraft at most airfields in the world (excluding large U.S. military facilities such as those in Germany) limits the number of daily sorties those airfields can support. CBO estimates that given those constraints, transporting a brigade equipped with the Army's existing armored vehicles to the east coast of Africa by air may take 23 days; moving an entire division similarly equipped may take 135 days, or more than four months (see Summary Table 3).[9] Brigades and divisions that are equipped with FCS components would take 18 to 20 days and 115 to 130 days, respectively.

In contrast, seagoing ships can easily transport very large amounts of the Army's existing equipment. Indeed, two or three of the Military Sealift Command's (MSC's) large seagoing ships can transport an entire brigade's worth of equipment, and eight of those vessels can transport an entire division overseas. Most coastal regions of the world have at least one large port capable of receiving the MSC's ships. And even though some of the equipment associated with a division equipped with either current armored vehicles or FCS components might have to be loaded onto some of the command's slower ships, it would still take far less time to deliver a full heavy division by sea—27 days—than by air.

Survivability

Finally, several observers have questioned the basic assumption that underlies the survivability of the lightweight FCS components—which is that those lightly armored vehicles will be able to survive on the battlefield because they will have extensive knowledge of the enemy's whereabouts, allowing them to avoid unexpected or disadvantageous encounters with enemy forces. If, however, the FCS sensors and communications network do not work as planned, the ability to avoid such encounters—and thus the armored vehicles' survivability—are uncertain. Moreover, other people, including soldiers returning from duty in Iraq, have argued that the most sophisticated sensors will not be able to detect and predict the kinds of dangerous situations that are now prevalent there.

9. CBO used as an example the transporting of Army units from the United States to Djibouti, on the east coast of Africa, to illustrate the trade-offs involved in moving units overseas.

Alternative Approaches to Modernizing the Army's Heavy Forces

CBO has analyzed four different options for modernizing the Army's armored units that would address major concerns about the FCS program—specifically, its technical feasibility, its cost, and the slow rate of introduction of its systems into the Army's force structure. Under the first three of those alternatives, the Army would retain different components of the FCS program (to emphasize systems that would contribute to different objectives of modernization) while canceling the remainder.

- Under Alternative 1, the Army would develop and purchase the full suite of sensors called for in the FCS program (to provide enhanced information-collection capabilities) and a version of the FCS network (to disseminate that information). With greater knowledge about the location and character of potential threats and the whereabouts of allies, Army forces, some argue, would be better able to respond and act appropriately, either individually or in concert.

- Under Alternative 2, in addition to developing and purchasing a scaled-down version of the FCS network, the Army would emphasize those of the program's systems that would enhance its ability to attack targets at ranges of greater than 20 km (that is, long-range strike missions).

- Under Alternative 3, the service would focus, first, on enhancing the maneuvering ability of the Army's combat brigades by developing several of the new manned ground vehicles (particularly those that would replace the older M113-based vehicles and M109 howitzers currently in the fleet) and, second, on developing and purchasing a modified version of the FCS network to tie them together.

- Under Alternative 4, the Army would greatly reduce the scope of the FCS program, developing only a scaled-down network and integrating it with existing systems.

Under none of the alternatives would the service develop or procure the unmanned ground vehicles or intelligent munitions systems that are currently planned for the FCS program; however, under all of them, it would upgrade existing armored vehicles to convert them to the latest model of the current system and prevent their average age from increasing. Such upgrades would also integrate the capabilities associated with the retained portions of the FCS program when those new systems became available (see Summary Table 4).

Alternative 1. Develop and Procure FCS Components That Will Collect and Disseminate Information

To collect as much information as possible, the Army under this alternative would develop and procure the unattended ground sensors and all four classes of unmanned aerial vehicles included in the FCS program. It would also develop a less ambitious and less extensive version of the FCS network and install it in existing armored vehicles so that they could receive and exchange the information collected by the FCS sensors. All other FCS components, including the manned and unmanned ground vehicles, the non-line-of-sight launch system, and the intelligent munitions system, would be canceled.

CBO estimates that total costs under this alternative—without taking historical cost growth into account—would be $99 billion from 2007 through 2025, versus $140 billion for the full FCS program (without upgrades) for the same period. (However, costs for this alternative could reach $131 billion if they grew as they have in the past for similar defense programs; under the Administration's plan for the FCS program through 2025, costs could grow to $231 billion.) Costs for the FCS components developed and purchased under this alternative would be $61 billion from 2007 through 2025, in CBO's estimation; costs for upgrading the existing armored vehicle fleet would be $38 billion for the same period (see Summary Table 5). Annual costs to implement Alternative 1, which are just under $6 billion after 2015, would include about $2 billion to upgrade roughly 560 vehicles per year (see Summary Figure 1 on page xiv).

One of the advantages of this approach is that the Army could introduce new technology into its units more rapidly than under the Administration's plan and at a lower cost. Because the service would be pursuing some of the least technologically risky of the FCS components, it could begin introducing them in 2010. And because those systems are also the least expensive of the 18 new components, the Army would purchase them at rates

Summary Table 4.

Emphasis of and FCS Components Included in Alternatives

Alternative	Emphasis	FCS Components	
		Retained	Canceled
Alternative 1	Collection and sharing of information	Scaled-down network All classes of UAVs Unattended ground sensors	All manned vehicles All unmanned ground vehicles Non-line-of-sight launch system Intelligent munitions system
Alternative 2	Long-range strikes	Scaled-down network UAV Classes III and IV Unattended ground sensors Non-line-of-sight launch system	All manned vehicles UAV Classes I and II All unmanned ground vehicles Intelligent munitions system
Alternative 3	New vehicular technology	Scaled-down network Manned vehicles Medical Infantry carrier[a] Non-line-of-sight mortar Non-line-of-sight cannon Command and control	All unmanned ground vehicles Manned vehicles Mounted combat system Recovery and maintenance Reconnaissance and surveillance All classes of UAVs Non-line-of-sight launch system Unattended ground sensors Intelligent munitions system
Alternative 4	Network integration with existing systems	Scaled-down network	All manned vehicles All unmanned ground vehicles All classes of UAVs Unattended ground sensors Non-line-of-sight launch system Intelligent munitions system

Source: Congressional Budget Office.

Note: UAV = unmanned aerial vehicle; FCS = Future Combat Systems.

a. Under Alternative 3, the Army would buy roughly 25 percent of the infantry carrier vehicles included in the Administration's plan.

twice as high as the Administration's planned 1.5 brigades' worth per year—that is, it would purchase 33 brigades' worth of the FCS sensors and UAVs as well as the network by 2025. And, CBO estimates, besides the lower total costs that this alternative would provide, relative to those under the Administration's plan, cost growth would probably also be less—30 percent compared with roughly 60 percent under the Administration's plan. Although the Army under this alternative would incorporate some of the capabilities for sharing information to be provided by the FCS network, vehicle survivability would not depend as heavily on those capabilities as it would under the Administration's plan.

The speed of deployment of the Army's heavy units would be little affected under this alternative because the service would retain the armored vehicles now in those units. Indeed, if the alternative was implemented, the weight of a typical heavy brigade would increase slightly—because additional trucks would be needed to support and transport the large number of UAVs that would be added to each brigade, increasing the time needed to airlift the brigade overseas by half a day. If transported by sea, however, the additional vehicles would not affect the time required to deploy a brigade- or division-sized unit—because the additional vehicles and supporting gear would fit easily on the ships used to move similar units with existing equipment (see Summary Table 3 on page xix).

Summary Table 5.

Total Acquisition Costs from 2007 to 2025 for the Administration's Plan and Alternatives

(Billions of 2006 dollars)

	Research and Development	Procurement	Total Acquisition
		Administration's Plan	
Costs Included in the President's Budget			
FCS Program's Increment 1[a]	21	101	122
Upgrades to existing vehicles	0	6	6
Further Costs as Estimated by CBO			
Continued purchases of FCS components, 2023 to 2025	0	18	18
Additional upgrades to existing vehicles[b]	2	15	17
Total	**23**	**139**	**162**
		Alternative 1. Collection and Sharing of Information	
FCS Components[c]	15	46	61
Upgrades to Current Systems[b]	2	36	38
Total	**17**	**82**	**99**
		Alternative 2. Long-Range Strikes	
FCS Components[d]	15	52	67
Upgrades to Current Systems[b]	2	36	38
Total	**17**	**89**	**106**
		Alternative 3. New Vehicular Technology	
FCS Components[e]	16	52	67
Upgrades to Current Systems[b]	2	33	35
Total	**18**	**85**	**103**
		Alternative 4. Existing-System Upgrades	
FCS Network	14	16	30
Upgrades to Current Systems[b]	2	36	38
Total	**16**	**52**	**68**

Source: Congressional Budget Office based on data from the Department of the Army.

Note: The estimated costs presented in this table do not take into account the possibility that costs may grow as they have in similar defense programs in the past.

FCS = Future Combat Systems.

a. Includes costs to develop and purchase the first 15 brigades' worth of FCS components—enough to equip slightly more than half of the Army's planned 27 heavy brigades (19 brigades in the active Army and eight brigades in the Army National Guard).

b. Includes upgrades to Abrams tanks, Bradley fighting vehicles, M113-based vehicles, and M109 howitzers to maintain a relatively constant average age for each fleet of vehicles after 2011.

c. Includes unattended ground sensors, unmanned aerial vehicles (Classes I, II, III, and IV), and the network.

d. Includes unattended ground sensors, unmanned aerial vehicles (Classes III and IV), the non-line-of-sight launch system, and the network.

e. Includes manned vehicles (command and control, medical, non-line-of-sight mortar, non-line-of-sight cannon, and infantry carrier) and the network.

This alternative would suffer from several disadvantages when compared with the Administration's plan for the FCS program. Under this approach, the Army would retain the armored combat vehicles in its current fleet indefinitely, and by 2040, some of those vehicles would have been in the Army's inventory for almost 60 years. Another disadvantage is the technical risk involved in introducing network technology and associated communications links into old weapon systems, such as the Abrams tanks and Bradley fighting vehicles. Previous attempts to upgrade the communications and other electronic suites in those vehicles have met with difficulties.

Alternative 2. Develop and Procure FCS Components That Will Enhance the Army's Long-Range Strike Capability

Under the second alternative, the Army would retain those portions of the FCS program that enhanced its ability to carry out long-range strikes. Specifically, it would develop and procure the unattended ground sensors and longer-range UAVs (Classes III and IV) to detect and track targets. It would also develop and procure the non-line-of-sight launch system and its associated missiles to attack those targets. The combination of the UAVs and the missiles developed for the launch system would allow a brigade equipped with those weapons to identify and attack targets as far away as 70 km—long before most enemy weapons would be able to strike the corresponding U.S. targets. All of the ground vehicles in the FCS program, both manned and unmanned, would be canceled under this alternative, as would the shorter-range UAVs (Classes I and II) and the intelligent munitions system (see Summary Table 4 on page xxi). In addition, the Army would retain and upgrade the armored vehicles in its current inventory and develop and procure a scaled-down version of the FCS network (to tie the sensors and manned systems together).

Like the previous option, Alternative 2 would encompass the development and procurement of some of the least expensive of the proposed FCS components. As a result, annual procurement rates could be higher than under the Administration's plan, and annual savings—relative to that plan—could still be achieved. Specifically, the Army under this alternative would buy three brigades' worth of sensors, missile launchers, and network hardware annually starting in 2016 and continuing through 2025. Total costs for those systems, CBO estimates, would be $67 billion from 2007 through 2025 (see Summary Table 5). Costs for upgrading the armored vehicles in the Army's current fleet would be identical to those under the previous alternative—$38 billion—over that same period.

All told, costs under this alternative would total $106 billion from 2007 through 2025—$7 billion more than the costs under Alternative 1 but considerably less than those under the Administration's plan. Annual costs under this alternative would be roughly $6 billion to $7 billion (see Summary Figure 1 on page xiv).

Compared with the Administration's plan, this alternative would increase the firepower of Army brigades sooner and at a lower cost. Because parts of the FCS program—primarily the high-risk ground vehicles—would be canceled, costs under this alternative would be $40 billion less from 2007 through 2025 compared with costs for the Administration's plan when it includes the full FCS program (but no upgrades), extended through 2025. Notwithstanding, high-volume missile launchers would be introduced into a larger proportion (almost two-thirds) of Army combat brigades. The potential for cost growth under Alternative 2 is also more favorable than under the Administration's plan—34 percent versus 60 percent. (If costs grew as they have in the past, acquisition costs under this alternative could be as high as $142 billion, compared with $231 billion for the full FCS program and planned upgrades.) Because the Army would invest significantly in upgrades under this approach, the average age of the resulting armored combat vehicle fleet would be much lower than that resulting under the Administration's plan (see Summary Figure 2 on page xvii). In addition, this alternative would achieve survivability by means other than dependence on what could be a problematic network.

In emphasizing systems that would improve the Army's ability to carry out long-range strikes, this alternative would not compare favorably with the Administration's plan on at least two counts. First, the Army would indefinitely retain armored vehicles that were originally designed in the 1970s or earlier, which could make it difficult to integrate those vehicles into a network that would tie them and the FCS sensors and launchers together. Second, under this alternative, the Army would increase the weight and bulk of its heavy units as trucks to support the UAVs and missile launchers from the FCS program were added to each brigade. As with the previous alternative, that would mean an increase—in this case, one day—in the time needed to deploy a heavy brigade by air

but no increase in the time required to deploy it by sea (see Summary Table 3 on page xix).

Alternative 3. Emphasize Investment in New Manned Combat Vehicles

The third alternative envisions that the Army will develop and procure five types of manned vehicles through the FCS program to replace the oldest of its combat vehicles—the M113-based vehicles and M109 howitzers—currently assigned to combat brigades (see Summary Table 4 on page xxi). The FCS components would address at least some of the problems—such as the inability of the M109 howitzers to keep up with the newer models of the Abrams tank and Bradley fighting vehicle—that the Army has said are associated with keeping the older vehicles in its combat units. The Army's other armored vehicles (the Abrams tanks and Bradley fighting vehicles and those M113-based vehicles and M109 howitzers in units outside of heavy combat brigades) would be retained and upgraded so that they could be integrated into a scaled-down FCS network, which is another element of this alternative. All other parts of the FCS program—specifically, all four classes of UAVs, all unmanned ground vehicles, the non-line-of-sight launch system, the unattended ground sensors, the intelligent munitions system, and the remaining three types of manned FCS vehicles—would be canceled (see Summary Table 4 on page xxi).

CBO estimates that costs under this alternative will be similar to those under the previous two alternatives, requiring a total investment (excluding cost growth) of $103 billion from 2007 through 2025. Of that total, $67 billion would be needed to develop the five variants of manned vehicles and purchase 23 brigades' worth of equipment by 2025. Upgrading the armored vehicles retained under this alternative would cost $35 billion from 2007 through 2025 (see Summary Table 5 on page xxii).

Because the manned vehicles are among the most technically challenging of the FCS components and require the longest time to develop, purchases of those systems under this alternative would not begin until 2014. Consequently, the annual funding required would be less than that required under the previous two alternatives and the Administration's plan—until 2015 (see Summary Figure 1 on page xiv). Furthermore, because manned vehicles represent the most expensive of the 18 FCS components, their annual purchases would be limited to two brigades' worth, one fewer than under the previous two alternatives. Nevertheless, annual costs for this option, at roughly $6.5 billion, would be slightly greater than those under the previous two alternatives after 2015 but still significantly less than those under the Administration's plan.

Among the approaches CBO considered, this alternative is unique in its introduction of new vehicular technology into the Army's forces. Because new armored combat vehicles would be introduced more quickly under this alternative than under any other—including the Administration's plan—some of the Army's oldest armored vehicles would be retired earlier, and the average age of the resulting fleet would ultimately be the lowest (see Summary Figure 2 on page xvii). The alternative's costs are on a par with those of Alternatives 1 and 2; they are less than those of the Administration's plan. But because this alternative would emphasize the development and procurement of ground vehicles, which have experienced the highest rate of historical cost growth, the potential for such a rise in costs is greater—at 55 percent—than under the previous two alternatives and could add $57 billion to total costs.

This alternative shares some disadvantages with Alternatives 1 and 2. Under this approach, the Army would indefinitely retain both the Abrams tank and Bradley fighting vehicle fleets—whose original designs date from more than 30 years ago—and would attempt to incorporate the technology associated with the FCS network into those vehicles, a plan that could pose technical difficulties. Moreover, implementing the alternative would have little effect on units' deployment. On average, FCS vehicles would replace about half of the armored vehicles now in a heavy brigade; roughly 90 percent of those existing vehicles would be M113-based systems—which weigh less than the FCS vehicles that would replace them. As a result, the total weight of a heavy brigade could increase by as much as 6 percent under this alternative and in turn add one day to the time it would take to deploy such a brigade overseas by air. However, the time required to deploy either a brigade- or division-sized unit by sea would not increase (see Summary Table 3 on page xix).

Alternative 4. Develop a Scaled-Down FCS Network and Integrate It with Existing Systems

The last alternative that CBO examined would preserve only that portion of the FCS program designed to develop and support the network (see Summary Table 4 on page xxi). The new capability—a scaled-down version of the network currently envisioned for the FCS program—would then be incorporated into existing armored vehi-

cles, allowing the Army's combat brigades to benefit from an evolutionary improvement rather than a wholesale makeover based on unproven technology. All other portions of the FCS program would be canceled.

Under Alternative 4, the Army would purchase the least amount of hardware, by comparison with that purchased under the other alternatives, and would incur the lowest costs—$68 billion from 2007 through 2025. CBO estimates that $30 billion of that total will be needed to develop and purchase the hardware for the FCS network and that costs to upgrade the Army's existing armored vehicles will be $38 billion (see Summary Table 5 on page xxii). Some of the capabilities of the FCS network would be incorporated into the Army's current fleet of vehicles under this alternative, but the survivability of those vehicles would not be at risk if the network failed to perform as planned. Despite the fact that three brigades' worth of FCS network hardware would be purchased annually starting in 2012, the annual funding needed to implement this alternative would be roughly $3 billion in 2018 and thereafter (see Summary Figure 1 on page xiv). Under this alternative, the Army would have purchased enough network hardware by 2025 to upgrade almost two-thirds of its combat brigades. Moreover, because the Army would not develop or purchase any FCS components with high historical rates of cost growth, the potential for such growth under Alternative 4 would be relatively low—about 40 percent, or a total additional cost of $26 billion.

The speed of deployment of Army units overseas would be unaffected under this alternative because no new weapon systems would be added to existing Army combat brigades and no existing systems would be replaced by new ones. The time needed to deploy a heavy brigade overseas by air or by sea would be the same as it is for brigades equipped with existing armored vehicles—23 days and 25 days, respectively. Similarly, there would be no change in the time needed to deploy a division-sized unit by sea, which would remain at 27 days (see Summary Table 3 on page xix).

Because this alternative calls for so little investment in new technologies and equipment, it would also offer the fewest benefits from innovation, relative to the other approaches. Even though upgrades would maintain the average age of the Army's fleet of armored vehicles at about 13 years through 2040 and the vehicles would be connected by a new network, they would still be the same systems that the Army has had for the past 20 years. And some of them—notably those based on the M113 chassis—have been in the Army's armored combat vehicle fleet since the Korean War.